
- WSFS 1989
- S & J Ranch 1989
- KAC 1989
- Paramount Ranch 1989

- **WSFS 1989**
  - yield and cold tolerance
  - Verticillium tolerance

- **S & J Ranch 1989**
  - yield and cold tolerance

- **KAC 1989**
  - yield and cold tolerance

- **Paramount Ranch 1989**
  - yield and cold tolerance
  - salinity tolerance
Cold Tolerance: Dec. 1990

- 11 nights @ 4-12 C

  - UC Berkeley I: UCBI
    - No death
  - Pioneer Gold I: PGI
    - 41% died
Trunk Diameter Increase of ‘Kerman’ Pistachio as a Function of Increasing Salinity

- **P. Atlantica**
- **UCB 1**
- **P. integerrima**

**Axes:**
- **Relative trunk diameter increase**
- **Soil solution electrical conductivity (dS·m⁻¹)**
Partitioning of Cl⁻ Between ‘Kerman’ Pistachio Scion and Rootstock Wood as Influenced by Increasing Salinity Chloride

![Graph showing partitioning of Cl⁻ between rootstock and scion under different soil solution electrical conductivities.](image-url)
Partitioning of Na\(^+\) between ‘Kerman’ Pistachio Scion and Rootstock Wood as Influenced by Increasing Salinity Sodium

![Graph showing partitioning of Na\(^+\) between rootstock and scion of Pistachio species under varying salinity conditions. The graph includes bars for different soil solution electrical conductivity values (3.5, 8.7, 12, 16 dS m\(^{-1}\)) and species (P. integerrima, UCB 1, P. Atlantica).](image-url)
Conclusions: Greenhouse Trial:

- **soil salinity limits:**
  - 4 – 8 dS/m
  - 12 dS/m = 50% growth decrease

- **limiting factor(s):**
  - not specific ion damage
  - osmotic pressure
CONCLUSIONS: FIELD TRIAL:

- soil salinity limits: 8 dS/m
  - mature producing trees
  - on commercial rootstocks

- limiting factor:
  - not specific ion damage
  - osmotic pressure
Production Recommendation:

- **Irrigation:**
  - saline water = 8 dS/m can be used to irrigate established pistachios

- **Limiting factors:**
  - soil saturation
  - osmotic pressure
  - Cl and Na uptake with Integerrima
Tree salt tolerance

Average Rootzone Salinity (ECe)

Yield Potential, %

Pistachios

Plum

Citrus

Almond

Olive

Date Palm
## San Joaquin Valley Pistachio Rootstocks 1989 - 2002

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>Frost</th>
<th>Yield</th>
<th>Salinity</th>
<th>Vert.</th>
</tr>
</thead>
<tbody>
<tr>
<td>P. integerrima</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>P. atlantica</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>PGII</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>UCB1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
Rootstock Effects on Pistachio Trees Grown in *Verticillium dahliae*-Infested Soil

L. Epstein, B. Beede, S. Kaur and L. Ferguson
P. Atlantica Rootstock
P. Atlantica Scion
Introduction: Pathogen

Verticillium dahliae: Verticillium wilt

Alternate hosts:
- cotton
- solanaceous weeds
- tomato
Control:

Fumigation: reduce microsclerotia
  - methyl bromide preplant
  - solarization preplant or in-season

Resistant rootstock: 1982
  - *P. integerrima*: Pioneer Gold 1 (PGI)
Rootstock breeding: 1980’s

- *P. atlantica* X *P. integerrima*
  - UC Berkeley I: UCBI
    - moderate resistance
  - Pioneer Gold II: PGII
    - susceptible
Objective:

Evaluate Verticillium’s effects on growth and yield in a field production trial

- Four rootstocks
  - *P. integerrima*: resistant control
  - *P. atlantica*: susceptible control
  - UCBI: moderate resistance
  - PGII: susceptible
Plot:

- WSFS: 1990/1992
- Uniformly infested soil
- 18 rows X 18 trees @ 5m X 6m
- 64 completely randomized blocks
  - I U A II
Annual:

- Vigor rating: 0 -> 5
  0 = dead, poor, fair, good, excellent
- Pathogen ID
- Trunk circumference
- 1998 - 2002 yields
- Destructive sampling
  - Pathogen recovery
  - Symptom severity
Uninfected UCBI Rootstock

No xylem discoloration
Uninfected Scion on UCBI Rootstock

No irregular discoloration
Infected PGII Rootstock

Xylem discoloration

<5: mild infection

>5: moderate infection
Infected Scion on PGII Rootstock
Results: Verticillium effects

Horticultural factors:

- scion vigor
- symptoms
- mortality
- growth
- yield
Tree Vigor Evaluation and Mortality 2002

% of Trees

- P. integerrima
- P. atlantica
- PGII
- UCB1

- Excellent
- Good
- Fair
- Poor
- Dead
Vigor and Verticillium Symptoms: Surviving Trees • 2002

% Trees with Symptoms

Average Vigor

P. integerrima  P. atlantica  PGII  UCB1

0  10  20  30  40  50  60  70  80  90  100

a  b  a  b  a  b

5  4  3  2  1  0
Trunk Circumference and Yield/Tree
2002

Circumference (Cm)

Yield/tree (Kg)

P. integerrima  P. atlantica

PGII

UCB1

P. integerrima  P. atlantica
## Tree Vigor vs Marketable Yield per tree, kg ± SE

<table>
<thead>
<tr>
<th></th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P. integerrima</strong></td>
<td>22±1</td>
<td>27±1</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td><strong>P. atlantica</strong></td>
<td>23±3</td>
<td>29±1</td>
<td>16±1</td>
<td>9±2</td>
</tr>
<tr>
<td><strong>PGII</strong></td>
<td>28±4</td>
<td>24±2</td>
<td>15±1</td>
<td>9±1</td>
</tr>
<tr>
<td><strong>UCB1</strong></td>
<td>29±1</td>
<td>28±1</td>
<td>22±6</td>
<td>9</td>
</tr>
</tbody>
</table>
Conclusions:

Compared to PGI and P. atlantica:

- PGII appears susceptible
- UCBI appear resistant
Results:

Verticillium incidence and severity:

- scion vigor
- yield
PGI Rootstock
PGI Scion
P. atlantica Rootstock
P. atlantica Scion
PGII Rootstock
PGII Scion
<table>
<thead>
<tr>
<th>Rootstock</th>
<th>Vigor</th>
<th>Not infected</th>
<th>Mildly infected</th>
<th>Moderately or more infected</th>
<th>Percentage of trees of each rootstock</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P. integerrima</strong></td>
<td>Good or excellent</td>
<td>35</td>
<td>17</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fair or poor</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>P. atlantica</strong></td>
<td>Good or excellent</td>
<td>27</td>
<td>12</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fair or poor</td>
<td>0</td>
<td>0</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td><strong>PGII hybrid</strong></td>
<td>Good or excellent</td>
<td>4</td>
<td>8</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fair or poor</td>
<td>6</td>
<td>2</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td><strong>UCB1 hybrid</strong></td>
<td>Good or excellent</td>
<td>70</td>
<td>7</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fair or poor</td>
<td>5</td>
<td>2</td>
<td>3</td>
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Association of Infection and Yield

Yield (Kg ± SE)

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<th>P. atlantica</th>
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<th>UCB1</th>
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<tbody>
<tr>
<td>Not infected</td>
<td>±1</td>
<td>±2</td>
<td>±3</td>
<td>±1</td>
</tr>
<tr>
<td>Mildly infected</td>
<td>±1</td>
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<td>±3</td>
<td>±4</td>
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<tr>
<td>Moderately or more infected</td>
<td>±1</td>
<td>±2</td>
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Species:
- P. integerrima
- P. atlantica
- PGII
- UCB1
Conclusions:

Rootstock affects:

pistachio scion yield

• scion vigor
• extent of infection
• inverse association
Conclusions:

Rootstock Verticillium tolerance

• PGI $\geq$ UCBI
• P. atlantica
• PGII

WSFS 1989
- yield and cold tolerance
- Verticillium tolerance

KAC 1989
- yield and cold tolerance

S & J Ranch 1989
- yield and cold tolerance

Paramount Ranch 1989
- yield and cold tolerance
- salinity tolerance
## San Joaquin Valley Pistachio Rootstocks 1989 - 2002

### Limiting Factor

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Alternate Bearing: $0 - 1 = 0.67$